UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D. C. 20460

OFFICE OF PREVENTION,
PESTICIDES AND TOXIC
SUBSTANCES

PC Code: 128888
DP Barcode: D283774
2/26/03

Memorandum:

FROM: James K. Wolf, Ph.D., Soil Scientist
Environmental Risk Branch 3
Environmental Fate and Effects Division (7507C)

TO: Michael Goodis, Acting Branch Chief
Christina Scheltema, Chemical Review Manager
Reregistration Branch III
Special Review and Reregistration Division (7508C)

THRU: Kevin J. Costello, RAPL
Environmental Risk Branch 3

and

Stephanie Irene, Ph.D., Acting Branch Chief
Environmental Fate and Effects Division (7507C)

SUBJECT: EFED Review of Lactofen Small-Scale Prospective Ground-Water Monitoring Study 166-1 DER MRID #456717-01, 02, and -03.

The small-scale prospective ground-water monitoring study for lactofen on soybeans grown in Michigan has been reviewed by ERB3 and found to be acceptable to meet the 166-1 data requirements. Lactofen (Cobra Herbicide) was applied (and verified) at a rate of 0.4 lbs. lactofen per acre to a site presumably underlain by the Oshtemo sandy loam. The depth to water table ranged between . 14 to 19 feet below ground surface. Recharge from the surface was confirmed by the detection of a bromide tracer in both soil-water and ground-water samples. However, **neither lactofen or acifluorfen were found in ground water**. Acifluorfen residues were detected in the shallow and medium depth suction lysimeters (3 and 6 feet, respectively). The study provides valuable information concerning the degradation and dissipation of lactofen in soil, plus the formation, degradation, and leaching or dissipation of acifluorfen, applied as lactofen, in soil and soil pore water.

The permeability of the soils and the shallow water table depth at the study site represent vulnerable conditions for potential pesticide leaching. However, the amount of water applied to the site as precipitation or irrigation was generally less each month than suggested by EPA's draft PGW guidelines. Therefore, the study can be used to represent lactofen use on soybeans at vulnerable site under more-or-less typical or average moisture conditions.

The Agency (EFED) recommends that the following three requests be forwarded to the Valent. The first is voluntary the others are not. This in formation is being requested, because the Agency hopes to be able to use this information for evaluating new uses and chemicals in the future.

1. The Agency (EFED) is currently developing a Prospective Ground Water Study Data Base, in response to an Science Advisory Panel (SAP) suggestion. The intent of this database is to enable EPA and others to utilize the results of previously conducted studies to make predictions concerning new chemicals or old chemicals in new use sites. The Agency is encouraging registrants that have conducted studies to submit the study information in a format that has been developed for the database (in Microsoft Excel). If Valent is interested, the data template can be made available. The registrant also apparently has the daily historical weather data for the closest meteorological station (Three Rivers, Michigan meteorological station (208184)). The Agency would like the registrant to submit this information to better understand the variability of precipitation at the study site.

2. The amount of water applied (as precipitation or irrigation) to the study site must be sufficient both to grow a crop and to ensure recharge from the surface. Because, the tracer reached ground water during the course of the study, recharge was demonstrated. However, since the target moisture was based on precipitation alone, it is not clear whether added water was sufficient to produce an typical crop yield.

   There are a few ways that this could be clarified:

   - The yield obtained from the study plot could be compared to yields obtained from elsewhere on the cooperator's farm or from others in the county to demonstrate the production of an average crop. The soybean crop was harvested in 1999, but crop yield was not stated.

   - Other fields on the property that included the study site were equipped for irrigation. If the land owner irrigated any of the adjacent fields during the study, it would be instructive to know how the registrant's "target amount of precipitation" compared to the precipitation plus irrigation applied to other fields that the land owner irrigated.

3. A several minor issues and errors have been identified by the Agency. These issues and errors are being noted so that they can be addressed for correctness and completeness.
   The Agency has always envision one complete final report with all the information included, not as a bunch of separate pieces. Unfortunately, the final report is not a complete document, but makes reference previous submittals. Specifically, the final report has been submitted as an acrobat file (pdf) and paper copy, this report does not

include the site characterization data, and other information submitted to the Agency as interim reports. The Agency is not looking Valent to produce a new report, but the re-submittal of site selection data, interim reports along with the final report (all in pdf format) to make a complete stand alone record (e.g., series of pdf files). An outline or table of contents summarizing the organization of this information could accompany these (pdf) files. This is especially important since the final report refers to these other submittals which contain multiple appendices, attachments, and figures.

PC Code: 128888
DP Barcode: D283774
Date: February 6, 2003

DER

Shaughnessy No. 128888 Common Name: Lactofen CAS RN: 77501-63-4 Chemical Name: 1-(carboethoxy)ethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate Formulation: Cobra EC (emulsifiable concentrate) 23.2 % Active Ingredient (a.i.) Data Requirement: 166-1 File name: 128888 45691701 166-1 PGW-MI D283774 Lactofen DER.wpd

MRID #456717-01, 02, and -03
Freiwald, R.S., B. Wood, and A.F. Rose. 2002. A Small-Scale Prospective Ground Water Monitoring Study for Lactofen.
Performing Laboratories: LFR Levine-Fricke, Inc. and North Coast Laboratories Ltd.
Laboratory Project Identification: VP-12155
Study submitted by Valent U.S.A. Corporation, Walnut Creek, CA

REVIEWED BY:	James K. Wolf Environmental Scientist EFED/ERB3	Signature: Date:

REVIEWED BY:	Kevin Costello Geologist/RAPL EFED/ERB3	Signature: Date:

APPROVED BY:	Stephanie Irene Acting Branch Chief EFED/ERB3	Signature: Date:

CONCLUSIONS

The small-scale prospective ground-water monitoring study for lactofen on soybeans grown in Michigan is scientifically sound and is acceptable to use in the exposure and risk assessments containing lactofen and its degradate acifluorfen. Lactofen (Cobra Herbicide) was applied (and verified) at a rate of 0.4 lbs. lactofen per acre to a site presumably underlain by the Oshtemo sandy loam. The depth to water table ranged between . 14 to 19 feet below ground surface. Recharge from the surface was confirmed by the detection of a bromide tracer in boil soil water and ground-water samples. However, **neither lactofen or acifluorfen were found in ground**

water. The study provides valuable information concerning the degradation and dissipation of lactofen in soil, plus the formation, degradation, and leaching or dissipation of acifluorfen, applied as lactofen, in soil and soil pore water.

The permeability of the soils and the shallow water table depth at the study site represent vulnerable conditions for potential pesticide leaching. However, as described below, the amount of water applied to the site as precipitation or irrigation was generally less each month than suggested by EPA's draft PGW guidelines. Therefore, the study can be used to represent lactofen use on soybeans at vulnerable site under more-or-less typical or average moisture conditions.

The Agency (EFED) is currently developing a Prospective Ground Water Study Data Base, in response to an Science Advisory Panel (SAP) suggestion. The intent of this database is to enable EPA and others to utilize the results of previously conducted studies to make predictions concerning new chemicals or old chemicals in new use sites. The Agency is encouraging registrants that have conducted studies to submit the study information in a format that has been developed for the database (in Microsoft Excel). If Valent is interested, the data template can be made available. The registrant also apparently has the daily historical weather data for the closest meteorological station (Three Rivers, Michigan meteorological station (208184)). The Agency would like the registrant to submit this information to better understand the variability of precipitation at the study site.

BACKGROUND

The measured persistence and mobility of lactofen are such that it apparently has a generally low likelihood of contaminating ground water. However, the degradate acifluorfen is both mobile and persistent, and has been found in ground water at several locations. Acifluorfen is also formed by degradation of sodium acifluorfen, another registered pesticide.

A small-scale prospective ground-water monitoring study was previously conducted for lactofen in Ohio in response to a 1987 Data Call-In. EFED noted several flaws in the study (D203252), and classified it as "supplemental". These limitations included the lack of a tracer to document leaching, possible clay areas which may retard water flow, questionable analytical methods (e.g., limits of quantification and detections and analytical interference), relatively high detection limits, and inadequate verification of the rate of lactofen applied to the site. Some of these limitations could be dealt with by the registrant supplying additional data. The lack of a tracer and verification of application rate could not.

At the time of this review, the Agency is considering a request for a time-limited tolerance extension for residues of lactofen in and on cotton. The PGW study reviewed in this document was requested to address some unanswered questions concerning lactofen and its degradate acifluorfen. This data will be considered by EFED in its drinking water assessment for the lactofen human health dietary risk assessment required by the Food Quality Protection Act.

Lactofen Small-Scale Prospective Ground Water Study in Michigan

Because of monitoring data, fate properties, and the unanswered issues associated with the previous Ohio prospective ground water study (D203252), Valent (the registrant of lactofen) agreed to conduct a second lactofen small-scale prospective ground-water monitoring study. Lactofen is used for post-emergence control of annual broad-leaved weeds in soybean, cotton, kenaf, and snap beans. The majority of lactofen is used on soybeans.

The acifluorfen detections in ground water in the Wisconsin sodium acifluorfen PGW study and the soil dissipation in the sodium acifluorfen retrospective ground water study suggested that acifluorfen residues were more persistent in colder climates (D173298). Therefore, EFED recommended that the lactofen study be conducted in cold climate. A hydrologically vulnerable study site in St. Joseph County, Michigan was selected from among several possible sites considered by the registrant.

The choice of a "cold climate" site placed the emphasis of site selection on vulnerability, but not necessarily on intensity of pesticide use. States with the highest soybean production included Illinois (2^{nd}), Iowa (1^{st}), Minnesota (3^{rd}), and Missouri (4^{th}); Michigan was 11^{th} or 12^{th} and Wisconsin was 13^{th} or 14^{th} during the years 1999, 2000, and 2001 (NASS, USDA, Crop Production 2001 Summary, 2002). Suitable vulnerable sites could have also been identified in Illinois, Iowa, and Minnesota, that would also fit the "cold climate criteria".

METHODS AND MATERIALS

Test Substance

Cobra Herbicide EC [Emulsifiable Concentrate] (batch number VID-005EC-6) contained 23.5% lactofen by weight. The reference standards were from Lot Number As784i. The percent purity was 99.8%. The registrant applied Cobra at a rate of 0.4 lb. a.i./A, which is the maximum single season amount permitted by the label for soybeans.

Site Characterization

Site Selection and Representative Crop

The study area was situated in an approximately 40-acre agricultural field that was used in a corn-soybean rotation. A preexisting irrigation system was noted on site, so historically the owner-operator has irrigated the site. Lactofen had not been applied to the site for at least the five years before the study began on April 2, 1999. Weeds were controlled by Command, Syncor, and Roundup in soybean years, and Dual and atrazine when corn was planted.

Preliminary Site Inspection: The majority of the information concerning the soil borings and soil sampling for site characterization and instrument installation was presented in the first Interim Report (IR #1) (MRID #s 449981-01). Additional information is also included in the Final Report (MRID #456717-01, 02, and -03).

Preliminary site characterization (non-GLP) was used to characterize the surface and subsurface soil texture and measure aquifer properties. The depth to water table ranged between .14 and 19 feet below ground surface. The Registrant determined from the Natural Resources Conservation Service (NRCS) soil survey map (Soil Survey, St. Joseph County, Michigan, 1983), that the soil map unit at the site was the Oshtemo sandy loam [a Coarse-loamy, mixed, active, mesic Typic Hapludalfts]. The soil (0 to 66 inches) at the site was not described or sampled using methods described in the Soil Survey Manual (Soil Survey Division Staff. 1993. Soil Survey Manual. SCS, U.S. Dept. of Agriculture Handbook 18; http://www.statlab.iastate.edu/soils/ssm/gen_cont.html) and as recommended in the PGW draft guidelines. The soil (<66 inches) and subsoil (> 66 inches) were described, sampled, and analyzed by pre-determined increments (which varied by depth) and/or when there was a visible difference in the soil material (details follow).

The site was located in an area delineated on the soil survey map as Oshtemo sandy loam (map unit 4B), 0 to 6 percent slopes (Soil Survey, St. Joseph County, Michigan, 1983) (Attachment A4-2, page 148). Two other soils (the Spinks loamy sand and the Kalamazoo loam) are closely associated with the Oshtemo soils. However, while these soils have an argillic horizon, the soil characterization data suggest that there is not an argillic horizon present at the study site.

Because the soil characterization information (descriptions, sampling and analysis) does not conform to USDA-NRCS methods, OPP cannot "confirm" that soils at the site correspond with the Oshtemo soil series. However, from the information submitted by the registrant, the soil at the study site does appear to meet the Oshtemo soil criteria. More importantly, the site **does** meet the Agency's desire to conduct the study at a vulnerable site.

SAMPLING FOR SITE CHARACTERIZATION

The surface soil in the test plot was characterized during the drilling of piezometers P1 to P3 and by the 10-point surface samples, the 9-point well-installation samples, and the Shelby Tube samples. The methods by which the samples were collected and analyzed are detailed in Interim Report #1 (IR #1) (MRID # 449981-0).

Preliminary subsurface site characterization sampling was conducted on 17 and 18 November 1998, during the drilling of three piezometer borings (P1 to P3). Continuous soil samples were collected to a maximum depth of 26.5 feet. The split-spoon samples were laid out on plastic for lithologic description and partitioning into sample increments. Samples from each horizon were split into two sets of sub-samples, and placed in re-sealable plastic bags. One sub-sample was sent to Agvise and analyzed for soil texture, OM content, CEC, pH, disturbed bulk-density, Ca^{2+}, Mg^{2+}, K^{1+}, Na^{1+}, and H^{1+} by Agvise. The second was analyzed by Valent for lactofen, acifluorfen, and possible analytical interference. The soil characterization results were submitted in IR# 1.

10-Point Surface Soil Characterization Sampling: On 18 November 1998, ten two-inch diameter cores six inch (0-6 inch layers) were collected from within the test plot (VAL-MI-001-SS1 to VAL-MI-SS10) . The individual samples were homogenized, separated into two sub-samples, and placed into two separate re-sealable plastic bags. One sample was sent to the laboratory (Agvise) the second went to Valent. The samples were analyzed for percent sand, silt, and clay, OM content, CEC, pH, disturbed bulk density, and Ca^{2+}, Mg^{2+}, K^{1+}, Na^{1+}, and H^{1+} by Agvise. Valent analyzed samples for lactofen, acifluorfen, and possible analytical interference. A portion of results of the 10-Point Soil Sampling are summarized in Table A.

Table A. Summary of 10-Point Sampling of Study Site						
Property[1]	Mean[2]	Standard Deviation	CV%[3]	Minimum	Median	Maximum
Sand (%)	82.2	4.0	4.93	78	81	88
Silt (%)	13.2	3.2	23.90	8	14	16
Clay (%)	4.6	1.4	29.35	2	4	6
CEC (meq/100g)	5.68	0.59	10.33	4.5	5.85	6.6
OM (%)	0.96	0.14	14.06	0.8	0.9	1.2
pH	5.97	0.36	5.96	5.4	6.0	6.4

[1] Depth (0 to 6 inches)
[2] Sample size = 10
[3] CV% = Coefficient of variation (CV% = (Standard Deviation/Mean) * 100)

9-Point Well-Installation Soil Sampling: The 9-point sampling was conducted from 6 to 8 April 1998, during the drilling of the nine deep monitoring wells. Continuous soil cores were collected to a maximum depth of 28 feet. While the shallow ground-water monitoring wells (MW-1S to MW-8S) were also installed at the same time as the deep wells, samples were not collected for analysis.

The mean, minimum, median, and maximum percent sand, silt and clay, and percent organic matter (OM) of all 167 samples collected from the nine deep monitoring wells (MW-1D to MW-8D and MW-UD) are summarized in Table B. A more complete descriptive statistics (by segment or depth) assessment of these and other measured properties is summarized in Attachment 1. The continuous cores (0" to typically 336") were segmented as described above for the surface sampling program. The segments for the first 12-sampling increments of nine deep monitoring wells were in 6-inch segments. The remaining lengths were segmented based visible changes in the lithology, and therefore were not necessarily continuous nor of equal segment lengths. Each of the first 12 layers (Attachment 1) or sampling increments, were equal lengths so that the descriptive statistics presented in Appendix 1 were based upon samples with same length and depth. Below this depth the sampled increments were placed into sequential layers the more or less fit the sample location and increment length. This was done solely for computational simplicity and the presentation of data, and not for a rigorous statistical assessment.

The soil properties (percent sand, silt, clay, OM) measured from samples obtained during the installation of Piezometers P1 to P3 are similar to those presented in Table B. These results were not include in the analysis in Table B, because the segmenting of the cores for sampling was slightly different.

Table B. Summary of Selected Properties from 9-Point Sampling of Subsoil on Study Site (Interim Report # 1, MRID # 449981-01, Appendix 6-2, pages 183 to 190)				
Property	Mean[1]	Minimum	Median	Maximum
Sand (%)	89.2	38.0	93.0	98.0
Silt (%)	4.77	0.00	3.00	22.0
Clay (%)	6.10	0.00	5.00	47.0[2]
OM (%)	0.27	0.00	0.20	2.50[3]

[1] Sample size = 167 Monitoring wells MW-1D to MW-8D and MW-UD.
[2] Two samples 300-306" and 330 to 336" had 21 and 47 % clay, respectively. Remaining 165 samples had less than 20 percent clay.
[3] One OM (organic matter) value was 2.50, remaining were 1.4 % or less.

The soil characterization data collected during the 9-point sampling of the subsoil show that the vadose zone consists of predominately sandy textures (sand, loamy sand and sandy loam) and low organic matter content (Table B). Ninety-four percent of the samples had a clay content of 15% or less. A single increment (60-66 inches) had a 2.5 % organic matter content, but the majority (94.6%) of the OM were #1.0% OM and 99.4% were # 1.4% OM.

There was a strong correlation (Pearson's) between percent clay and the water holding capacity at field capacity (1/3-bar) and wilting point (15-bar) (Table C.). It has been reported that it is better to use undisturbed soil samples for the wet end (0 to 1 bar) of the moisture spectrum, since the soil structure has an important influence on soil water retaining properties (Burke et al., 1986). Soils at the dry end (15-bar) of the moisture spectrum are more closely related to particle size (e.g., clay content). Since both parameters were determined on disturbed soil material, the good correlation is not surprising. The water contents at field capacity measured here are probably lower than the in-situ field capacity values (undisturbed in place).

Table C. Pearson Correlation and P-value for clay content, field capacity, and wilting point.			
	Sand (%)	Clay (%)	Field Capacity (%)
Clay (%)	-0.897 (0.00)		
Field Capacity (%)	-0.899 (0.00)	0.871 (0.00)	
Wilting Point (%)	-0.879 (0.00)	0.940 (0.00)	0.912 (0.00)

Shelby Tube Sampling (Undisturbed core samples): Shelby tube sampling was conducted on 8 April 1999 to obtain "relatively" undisturbed samples for the measurement of vertical saturated hydraulic conductivity, undisturbed bulk density, and percent moisture (soil water content). Six cores (ST-1, ST-3, ST-4, ST-5, ST-6, and ST-8) were collected (Figure 4, page 55 MRID #449981-01). The Shelby tube has 3-inch (OD) and is 30 inches long. Each sample collects nominally a two-foot interval. A hollow-stem auger drill rig was used in advance of the Shelby tube in each soil profile. Samples were collected to about 18 feet. The sampling was performed in accordance with GLP methodologies. Each Shelby tube was sealed at both ends with paraffin. Bore holes were backfilled with bentonite chips and re-hydrated with water. Each sample was sub-divided by length (thirty six 6-inch increments) and used for determination of saturated hydraulic conductivity, undisturbed bulk density, and percent moisture. They analyses follow standard methodologies did not follow GLP.

The results of the Shelby Tube Sampling were presented in the IR#1 (MRID # 449981-01, Appendix 6-2, pages 191 to 197). The data are summarized here by descriptive statistics (Table D). Saturated hydraulic conductivity generally increased with depth and ranged from 0.4 to 220 cm/hr. The hydraulic conductivity reported by the USDA NRCS for the Oshtemo sandy loam ranges from 5.08 to greater than 50.8 cm/hr. These data (Table D.) show typical variability both with depth and area. Limitations in sampling, such as compaction, may be the source of the low hydraulic conductivity value (0.4 cm/hr). Another factor for the differences in hydraulic conductivity measured on site compared to the Oshtemo series is that the depths are not necessarily the same and the Shelby samples went to 18 feet, while USDA NRCS samples would typically only go to about 5 feet.

Table D. Summary of saturated hydraulic conductivity, bulk density, and gravimetric soil water content collected with the Shelby Tube (IR#1 MRID # 449981-01, Appendix 6-2, pages 191 to 197).

Statistic	Hydraulic Conductivity[1] (cm/hr)	Undisturbed Bulk Density[2] (g/cc)	Water Content[3] (%)
n	177	177	177
Mean	54.2	1.65	8.17
SD	48.73	0.12	3.42
C.V.	89.9	7.39	41.85
Minimum	0.40	1.15	2.60
Median	37.4	1.64	7.60
Maximum	220.0	1.98	21.00

1 Constant Head Hydraulic Conductivity. Black, C.A. (ed.) 1965. Methods of Soil Analysis, Part 1. American Society of Agronomy, Madison, Wisconsin (IR #1, MRID # #449981-01, Appendix 2, Page 81 to 83, SOP # NUT.02.34.02)

2 Undisturbed bulk density. (IR #1, MRID # #449981-01, Appendix 2, Page 77 to 78, SOP # NUT.02.02.03).

3 Gravimetric soil water. (IR #1, MRID # #449981-01, Appendix 2, Page 74 to 83, SOP #NUT.02.36).

SITE INSTRUMENTATION

The study plot area consisted of the test plot (. 2.6 acres) and a control plot (. 0.4 acres) surrounded by a buffer area. The plot was instrumented with 7 piezometers, 20 ground-water monitoring wells (10 shallow and 10 deep), 36 soil-suction lysimeters (porous tip samplers in nine cluster with four depths), a weather station, and a linear-tracking irrigation system. The study site was instrumented to be consistent with the minimum recommendations outlined draft OPP/EFED Small-Scale Prospective Ground-Water Monitoring Study Guidelines (USEPA, 1998, http://www.epa.gov/oscpmont/sap/1998/october/grndwtr.pdf).

Piezometers

Seven piezometers were installed (outside the plot and in the corners) at the study site. Piezometers were constructed with flush-threaded, 2-inch ID, schedule 40 polyvinyl chloride (PVC) casing and slotted well screen. The piezometers were installed with 15-feet of 0.010 - inch factory slotted well screen. The screened interval was placed so the top of the screen was above the top of the saturated zone at the time of installation. A sand filter pack was placed the space around the well screen to a depth of approximately two feet above the top of the screened interval. A three-foot-thick bentonite (grout) seal was placed on top the filter pack material. The bentonite was hydrated with water, and the piezometer was completely backfilled to the ground surface with bentonite chips hydrated with water (P1 to P3) or cement grout (P4 to P7). The piezometers were completed above the ground surface with a concrete pad, steel protective outer casing, and a locking cap. Each piezometer was developed after installation and initial ground water depth was measured.

Ground-Water Monitoring Wells

The nine ground-water monitoring well clusters were installed from 6 to 8 April 1990. Eight monitoring well clusters were installed in the treated plot (MW-1 to MW-8) and one 2-well monitoring cluster was installed in the control plot (MW-U). Each cluster had one shallow (S) and one deep (D) well which were spaced 10-feet apart. Two additional monitoring wells, MW-NS and MW-ND were installed on September 6, 2000. These wells were located up-gradient of both test and control plots (Appendix 2 of the Final Report).

Monitoring wells were constructed of 2-inch ID PVC casing and slotted screen as previously described for the piezometers (Attachment 6, Figure 5 page 158). The shallow monitoring wells contained a 10-foot length of screen positioned at about 12.5- to 23-feet below ground surface so the top of the well screen was above the top of the saturated zone. The deep monitoring wells had 5-foot screen positioned at about 22.5- to 28-feet below the ground surface. The monitoring wells were completed as previously described for the piezometers. The wells were completed above ground with a concrete pad, steel protective outer casing, and locking cap. A dedicated two-stage submersible pump with 3/8-inch ID high density polyethylene tubing was used to collect water samples from each well. The elevations of tops-of-casing and ground surface were professionally surveyed.

Lysimeters

Porous cup soil-suction lysimeters were placed in nine clusters of four lysimeters each. The placement of the lysimeters in the plot and lysimeter clusters are shown in Appendix 2 Figure 3, page 190 of the Final Report. One cluster (LY-U) was installed in the control plot and 8 clusters (LY1 through LY8) were installed in the treated area. The four lysimeters in a cluster were installed to different depths; 3-feet (shallow or S), 6-feet (medium or M), 9-feet (deep or D) and 13-feet (extra deep or X) below ground surface.

Typical lysimeter installation and construction are shown in Figure 4, Attachment A6, page 157 of final report. Lysimeters consisted of a PVC tube with a threaded porous cup at one end, a top plug fitted with two tube fittings, and high-density tubing routed to an above ground connection so that water samples could be collected. The boreholes for the lysimeters were drilled to the desired depth with a solid-stem auger. After a silica slurry was poured into the bottom of each lysimeter boring, the lysimeter was then inserted followed by 3- to 4-inches of soil. The remainder of the bore hole was filled with alternating layers of clean sand and bentonite. One vacuum/pressure tube and one sample delivery tube from each lysimeter were routed through a 15-inch deep trench (dug and refilled) through a common 4-inch diameter PVC pipe stickup. Tubing was marked to identify depth. All lysimeters were pressure tested and visually inspected before installation. After installation, each lysimeter was tested to ensure it would hold a vacuum of about 400 mm Hg for approximately 24-hours. To collect soil pore-water samples, each lysimeter was placed under vacuum for about 24-hours to draw pore water from surrounding soil through the porous cup. The vacuum was released and a mild pressure was added to force the collected water up through the other tube and into the collection container.

Irrigation System

The registrant installed a linear tracking irrigation system to supplement precipitation on the treated and control plots. The system is described in detail in the IR#1. The source of the irrigation water was an existing land owner’s well which was located about 1500 feet southeast of the test plot. The irrigation well was equipped with a turbine pump that could deliver 250 to 500 gallons per minute. The irrigation system was installed between May 5 and June 7, 1999 by Advanced Farm Supply. The system has three towers with a total span of 412 feet and has 43 nozzles which have a designed output of between 6.5 and 6.9 gallons per nozzle per minute with a 3-pound per square inch pressure.

On-Site Weather Station

A tripod-mounted automatic weather station was installed between April 10 and 14, 1999 and remained on site until it was decommissioned (July 18, 2001). It was located adjacent to piezometer P-4, outside the treated plot in the southeast corner of the study site (Appendix 2, Figure 3, page 190). The unit was grounded and equipped with a lighting rod to protect against lighting. The following information was collected: total precipitation (rainfall and irrigation; inches), air temperature (°C), soil temperature (°C) at 1-, 2-, 3-, 4-, 5-, 6-, 9-, and 13-feet below ground surface, soil water content (volumetric water content, %) at 1-, 2-, 3-, 4-, 5-, 6-, 9-, and 13-feet below ground surface, solar irradiance (Watts/m^2), water level depth in piezometer P-4 (feet bgs), wind speed (km/hr), wind direction (degrees), relative humidity (%), and barometric pressure (inches-of-Hg).

Weather data were recorded hourly and/or daily by a Model 23X weather station made by Campbell Scientific, Inc. Data were accessed remotely by a underground telephone line connected through a modem to the data logger. The specific instrumentation is define in Table E. Five additional manual rain gauges were placed in the field during irrigation events.

Table E. Summary of instrumentation for in field Meteorological station.	
Parameter (unit)	Instrumentation[1]
Total Rainfall (inches)	Texas Electronics model TE525 tipping rain gauge.
Air Temperature (°C)	Campbell Sci. HMP 45C Gauge
Soil Temperature (°C) at 1-, 2-, 3-, 4-, 5-, 6-, 9-, and 13-feet below ground surface	Campbell Sci. model 107-L probes
Soil Water Content (volumetric, %) 1-, 2-, 3-, 4-, 5-, 6-, 9-, and 13-feet below ground surface (bgs)	Campbell Sci. CS-615 probes
Solar Irradiance (Watts/m^2)	Campbell Sci. model LI-200SZ Pyranometer
Water-Level in Piezometer P-4 (ft bgs)	Pressure transducer model PS9105
Wind Speed (km/hr)	R.M. Young model 05103 Wind Monitor
Wind Direction (degrees)	R.M. Young model 05103 Wind Monitor
Relative Humidity (%)	Campbell Sci. HMP 45C Gauge
Barometric Pressure (inches of Hg)	Vaisala model PBT101 barometer

[1] The Agency does not endorse any specific product.

Aquifer Characterization

Aquifer properties were characterized from the lithology information collected during the soil boring activities associated with the installation of the piezometers and monitoring wells. Depth to ground water was measured and water-table contour plots developed so that the direction and hydraulic gradients of the ground-water flow could be determined (Table F). The hydraulic gradient and hydraulic conductivity (falling head-slug test in deep monitoring wells MW-1D, MW-2D, MW-7D, and MW-8D) were measured and porosity estimated to calculate aquifer pore-water velocity. Several aquifer properties are list in Table F. Methods used and Standard Operating Procedures are present in Appendix 3 of the Final Report.

Table F. Aquifer properties and characteristics.		
Aquifer Property or Characteristic	Value	Source of Information
Depth to ground water in Piezometers P-4 to P-7 on sampling dates	13.39 to 20.91 feet fluctuation 4.2 to 4.31 feet	App. 2,Table 2, page 178

Table F. Aquifer properties and characteristics.		
Aquifer Property or Characteristic	Value	Source of Information
Direction of Ground Water Flow	east to south east	App. 2, Table 3, page 180 Appendix 1-5, Figures 2-2 to Figures 2-28, pages 208 to 234
Hydraulic Gradient (ft/ft)[1]	average =1.44 (range 0.88 to 2.10)	App. 2, Table 3, page 180 and page 181
Aquifer Hydraulic Conductivity	1.1 x 10^{-02} to 2.1 x 10^{-2} ft/min or 15.8 to 32.2 ft/day	App.2, page 181
Aquifer Porosity	average .32% (range 25 to 40%)	App. 2, page 181
Aquifer Pore-Water Velocity (ft/day: ft/year)	average = 1.07:39 (range = 0.66 to 1.56: 24 to 57	App. 2, Table 3, page 180 and page 182

[1] Aquifer hydraulic gradient: $i = (h_1 - h_2)/d$ where i = hydraulic gradient (ft/ft), h_1 = water-table elevation (upgradient, ft), h_2 = water-table elevation (downgradient, ft), and d = horizontal distance (ft) between h_1 and h_2 along the perpendicular transect.

<u>Crop Planting, Cultivation, and Fertilizer Application</u>

The site was cultivated using conventional tillage methods and was irrigated during registrant defined growing season (to meet target amount of water added) as needed, from 1994 through 1998. The agronomic activities conducted for the study in the spring prior to the June 10, 1999 pesticide application are summarized in Table G. The soybean crop was harvested on October 19, 1999. The plot was left fallow after harvest; weeds were then controlled by mowing.

Table G. Summary of the Agronomic, Tracer and Pesticide Application schedule.		
DATE	ACTIVITY	EQUIPMENT
May 5, 1999	Control plot, test plot, and buffer area chisel-plowed to a depth of 6 inches	Graham 13 foot chisel plow
May 5, 1999	Control plot, test plot, and buffer area field cultivated to a depth of 4 inches	Brady 22 foot field cultivator
May 26, 1999	Control, test plot, and buffer area planted to soybeans[1]	Case International soybean drill model 510
June 9, 1999	Potassium-bromide tracer applied to test plot @ 100.9 lb/ac	15-foot pass width trailer mounted sprayer
June 10, 1999	Test substance (Lactofen) applied to test plot @ 0.401 lb ai/ac	15-foot pass width trailer mounted sprayer
October 19, 1999	Crop harvested	

[1] Soybean variety, Agripro 3032®, was planted at 75 pounds seed per acre by was a drill with a twelve-foot swath and 7-inch row-spacing.

A potassium-bromide tracer was applied on June 9, 1999 at the actual rate of 100.9 lb acre. Monitoring wells, piezometer, and lysimeter stick-ups were covered with clean plastic bags during the tracer application. A detailed description was present in Interim Report # 1.

Laboratory Methods

The analytical methods, analytes, matrices and method Limits of Detection (LOD) and Limits of Quantification (LOQ) are summarized in Table H. The analytical methods are described in detail in Interim Report #2.

Table H. Method, Analyte, Matrix, and method LOD and Method LOQ				
Valent Method	Analyte	Matrix	Method	
			LOD	LOQ
RM-28GW	lactofen, acifluorfen	ground water ground water	0.050 ppb 0.035 ppb	0.10 ppb 0.070 ppb
RM-28GW[1]	acifluorfen	soil-pore water	0.035 ppb	0.070 ppb
RM-28GWS	lactofen, acifluorfen	soil soil	1 ppb(ng/g) 1 ppb(ng/g)	2 ppb 2 ppb
RM-28V	lactofen	Verification Pads		
RM-40W	bromide	water		0.5 ug/mL

[1] Lactofen was not measured in soil-pore water samples.

RESULTS

Bromide in suction lysimeters

The detection of bromide residues in suction lysimeters at all depths and in some of the shallow and deep ground water monitoring wells shows that leaching occurred at the site during the study.

Bromide concentrations in soil-pore water were determined from water collected from the suction lysimeters from pre-application to 665 DAT (days after treatment). Bromide residues were detected in all treated plot suction lysimeters. There were no detections in the control plot lysimeters. One 9-foot deep lysimeter failed. Bromide analysis results for all media are detailed in the Final Report.

Bromide levels significantly exceeding background levels were detected in the shallow (3-foot) lysimeters at 90 DAT. Bromide concentrations peaked at about 150 DAT, and declined to near the LOD of 0.5 ppm by the end of the study.

In the medium deep (6-foot) lysimeters the bromide concentrations peaked between 150 and 300 DAT. By 330 DAT bromide concentrations began to decline. The concentrations were near 1 ppm on 665 DAT.

Bromide concentrations were detected in the deep (9-foot) suction lysimeters shortly after the medium deep lysimeters. Peak concentrations occurred at about 300 DAT. After 330 DAT bromide concentrations continually declined (0.57 to 2.7 ppm at 665 DAT).

Bromide breakthrough (>0.5 ppm) to the deepest (12-foot) suction lysimeters probably occurred between December 1999 and January 2000 (180 to 210 DAT). The arrival of peak concentrations varied greatly in these extra deep (XD) lysimeters, occurring at the earliest at 300 DAT. The peaks may not may not have occurred in two of the XD lysimeters which had maximum concentrations at day 665.

These results show considerable variation, but demonstrate that water was transported from the surface to ground water directly below the study site. Although the soil properties summarized in Table A (% clay, % sand, bulk density, etc) appear to be quite uniform, the arrangement (packing and distribution) of these properties have an influence on the movement of water through the soil. Because some lysimeter sampling events did not produce water samples, and since samples were collected on a preset schedule, it isn’t possible to know the maximum bromide concentrations in soil water, or when they occurred. However, it is sufficient for the bromide tracer to know the general breakthrough profile, in order to know the earliest dates when the applied pesticide might possibly be detected.

Bromide in ground-water monitoring wells

Bromide concentrations were below the method LOD (0.50 ppm) in all monitoring wells until 210 DAT. Bromide concentrations were detected in the shallow (15-ft) monitoring wells, with concentrations ranging from 0.52 to 8.0 ppm. Detections occurred in 3 wells by 270 DAT and in 6 wells by 300 DAT. The maximum detection occurred on 455 DAT (average 3.87 ppm). Bromide concentrations generally declined in the shallow monitoring wells after 485 DAT.

Bromide residues (0.59 ppm) were first detected in deep monitoring well #4 at 330 DAT. Bromide was detected in deep wells MW-D2, MW-D7, and MW-D8 at 395 or 455 DAT. After the initial detections, bromide levels remained fairly consistent, ranging from 0.76 to 3.8 ppm. Bromide residues were not detected in deep monitoring wells MW-D3, MW-D7, and MW-D8.

Bromide was first detected in the shallow-depth (15-ft) control plot monitoring well (Control 1) at 300 DAT and at 330 DAT in the corresponding deep-depth (25-ft) monitoring wells. These detections were low (0.66 ppm) at 330 DAT. New "up-gradient" monitoring wells were installed to verify that the bromide was not originating offsite. Bromide concentrations in the new control (Control 2) (up-gradient) wells were all less that LOD (<0.50 ppm). Bromide detections (maximum 3.8 ppm) continued in Control 1 (old) at both depths. The bromide was apparently from the treated plot, indicating that either the direction of ground-water flow was initially incorrect or it changed direction. The original flow direction was north. Page 63 of IR#2 indicates that the initial direction of ground water flow was incorrect, so additional piezometers (P4 to P7) were installed. The direction of flow was reassessed to be in east southeast direction.

<u>Acifluorfen in soil-pore water</u>

Soil-pore water samples were analyzed for acifluorfen but not lactofen. A laboratory study demonstrated that 70% of lactofen in water would be sorbed by silica flour used to construct the lysimeters and up to 99% would be sorbed by the lysimeter ceramic porous cup (DER Appendix 1). Acifluorfen was not readily sorbed during the lab study. The registrant requested not to analyze soil-pore water samples for lactofen, due to high degree of sorption of lactofen to the materials used in the construction and installation of the suction lysimeters. This request **was** acceptable to Agency.

The analytical method (Valent RM-28GW) used had a method LOD of 0.035 ng-acifluorfen/g-water (0.035 ppb), the LOQ is 0.070 ng-acifluorfen/g-water (0.070 ppb) on analysis of 40-g water (Table H). When the amount of water was less than 40 g, the LOD was higher.

No acifluorfen was detected in any of the lysimeters in the untreated control plot. Acifluorfen concentrations found in the suction lysimeters were summarized in Tables 7 (3-ft lysimeters), Table 8 (6-ft lysimeters), and Table 9 (9-ft lysimeters) (pages 42 to 44).

Acifluorfen was detected in shallow suction lysimeter LY-S3 at 30 DAT (0.15 ppb). This detection seems to correspond to the bromide movement and water front movement (as higher bromide detections generally occurred at this time). This is complicated, since as 3-foot suction lysimeter LY-S3 started out with background levels at -1 DAT (before tracer applied) of1.3 ppm (bromide). The registrant suggests that since acifluorfen arrived at this lysimeter at the same time as the tracer, preferential flow pathways can not be ruled out.

No acifluorfen was detected at 60 DAT. However, eight of nine suction lysimeters failed to produce 40-g sample at 60 DAT, so the LOD was great than 0.035 ppb (<0.081 to < 1.6 ppb). Acifluorfen was detected (0.37 to 1.7 ppb) in the shallow lysimeters in 5 of the 9 clusters at 90 DAT. Acifluorfen levels declined after this sampling, and by 270 DAT all shallow lysimeters were less then the LOD, except for lysimeter LY-S3 where detectable (but not quantifiable levels) were found until 425 DAT.

Acifluorfen was detected in water collected from one medium depth (6-foot) suction lysimeter (LY-M7) (Table 8, page 43). The highest concentration (0.87 ppb) occurred at 60 DAT and was higher than for the corresponding shallow-depth (3-foot) lysimeter (<0.081 ppb), on the same day. Detections in this lysimeter continued through 210 DAT. After this time all samples were less than LOD. Acifluorfen was not detected in soil-pore water at or below 9 feet.

<u>Lactofen and acifluorfen in ground water</u>

There were no lactofen or acifluorfen residues detected in any ground water samples collected through 665 DAT or at site decommissioning (765 DAT). As mentioned above, the analytical method has a LOD of 0.035 ppb and a LOQ of 0.070 ppb, based upon analysis of 40-g of water (Table H).

It was recognized that lactofen could adsorb to the PVC well casing. But since sorption is time dependent and since the monitoring wells are purged just prior to sample collection, time to allow potential sorption would be minimal.

<u>Lactofen and acifluorfen in soil</u>

Valent Method RM-28GWS was used to measure concentrations of lactofen and acifluorfen in soil. The method LOD is 1.0 ppb and the LOQ is 2.0 ppb for each analyte based upon analysis of a 5-g soil sample (Table H). Detailed analytical results (fortification recovery, storage stability, and sample analysis were given in Final Report, Appendix 3.

Soil samples were collected and analyzed from pre-treatment through 455 DAT, from 3 subplots in the control and from 5 subplots in the treated plot, and are summarized in Table L. No lactofen or acifluorfen residues were found in the control plot samples. The registrant determined a half-life, DT_{50}, andDT_{90} for lactofen in soil.

The soil analysis show that the lactofen dissipates rapidly from the surface layer (0 to 3 inches). The major dissipation of lactofen is probably the conversion of lactofen to acifluorfen. This is at least partially confirmed by the increase of acifluorfen over time. Acifluorfen has two major routes of dissipation and perhaps a third. The first possible route of dissipation of acifluorfen is leaching (i.e., low K_d values). This was confirmed by an Prospective Ground Water Study for Sodium Acifluorfen. A second route is the degradation of acifluorfen into amino acifluorfen. Amino acifluorfen is in the degradation pathway of sodium acifluorfen, but has not been shown in the Lactofen degradation pathway. Cited literature shows that at least for some soil textures, amino acifluorfen can have a fairly high sorption potential (DP Barcode: D280710, D278403). Additionally, cited literature indicates that some soils may have a higher potential to sorb acifluorfen than previously thought, based solely on partition coefficients (K_d). This could be a third route of dissipation.

Data shows that acifluorfen is leaching (as it is detected in shallow and medium depth suction lysimeters. While acifluorfen showed evidence of leaching, there was little evidence of increas ing concentrations (once peak is reached it starts to decline around 30 DAT).

Table L. Mean of soil residues (0 to 3 inch samples) of lactofen and acifluorfen with time (DAT - Days after treatment).

	DAT	MEAN/number	STD	Minimum	Maximum
Lactofen	0	338.0/5	48.7	270	390
	1	360.0/5	29.2	310	380
	2	123.4/5	25.8	97	160
	3	61.0/5	12.7	45	77
	5	23.6/5	6.0	17	33
	7	25.6/5	4.8	19	32
	14	27.0/5	5.8	21	35
	30	3.5/1		3.5	3.5
Acifluorfen	0	6.9/5	1.9	5.5	9.5
	1	7.7/5	0.7	6.7	8.4
	2	31.8/5	2.5	28	34
	3	70.0/5	3.4	66	74
	5	96.4/5	23.9	65	120
	7	87.2/5	13.1	79	110
	14	96.8/5	24.3	73	130
	30	43.2/5	15.5	32	67
	60	19.0/5	6.7	9.9	27
	140	4.3/5	2.1	2.1	6.9
	270	3.2/3	1.8	2.1	5.3

The decline of lactofen in soil (0 to 3 inch) soil horizon generally it an exponential decay function. The registrant presented the following equation to represent the decline of lactofen in soil during the study: $Y = 382\ e^{-0436X}$, where Y is the concentration in ppb, 0.436 is the decay rate, and X is the time in days. Their correlation coefficient was 0.92. Assuming first order kinetics, the half-life was 1.6 days (1.6 days = 0.693/0.436). A DT_{50} for lactofen from the soil was 1.7 days and the DT_{90} was 5.4 days. Too few detections occurred in the 3 to 6 inch increment to determine a decay rate. There were no residues measured in the soil samples at the 6 to 9 inch increment during the study.

The Agency confirmed the results using the Marquadt-Levenberg method for non-linear regression in the Software Package STATMOST (DataMost Corporation, 1994, SLC, Utah). The Agency's equation was $Y = 382.304e^{-0.43466X}$ with a correlation coefficient of 0.94, and half-life of 1.6 days. The DT_{50} is 1.59 days and the DT_{90} is 5.30 days.

The Agency also determined a dissipation half-life for acifluorfen, as the decline of acifluorfen did resemble a first-order decay function. However, there was not an exact time (DAT) for the maximum value for acifluorfen accumulation, thus depending upon the starting date, the half-life varied. The half-life and the data eliminated or summarized below in Table M. While the dissipation rate of acifluorfen varies by a factor of about 2, depending upon which data is used (initial time), it is clear that the dissipation of lactofen is much more rapid than acifluorfen.

Table M. First-Order Dissipation of Acifluorfen from 0-3 inches at Michigan PGW, depending upon initial time (data from Table 10, page 45).

DAT[1]	Equation	R-square	Half-life (days)
$5 DAT to 270	Y = 4.32 - 0.01529*t	0.80	45.3
$ 7DAT to 270	Y = 4.23 - 0.01475*t	0.78	47.0
$14 DAT to 270	Y = 4.08 - 0.01392*t	0.75	49.8
$ 30 DAT to 270	Y = 3.64 - 0.01145*t	0.71	60.5
$ 60 DAT to 270	Y = 3.08 - 0.00863*t	0.59	80.5

[1] Data used in the analysis.

The registrant suggests on page 34 that "either acifluorfen degradation was moderately rapid or that at least some degradation of lactofen was by a pathway that does not include acifluorfen. The latter hypothesis is not supported by the aerobic soil metabolism study.

DISCUSSION

The registrant has done a good job spatially characterizing a number of chemical and physical properties of the soil, vadose zone, aquifer, and ground water quality. Meteorological data was also collected (often on a hourly basis) on site during the study. This allowed for the collection of not only temporal data such as precipitation, temperature, relative humidity, but also ground water depth, soil temperature and water content at different depths during the duration of the study.

Pesticide application was verified by the concentration of lactofen on the Application Verification Pads . The average application of lactofen applied to the verification pads was 4.27 :g/cm^2 or 0.38 lb ai/acre (95% of desired rate of 0.4 lb ai/acre), prior to correction for method of recovery. Correcting for method of recovery, the application cards indicated about 100 percent of theoretical application rate was achieved. The average method recovery was reported as 94.5 percent in IR #2.

Precipitation and Irrigation

The registrant set an applied moisture target of 130 percent of the 30-year monthly average precipitation, measured from 1961 to 1990. The draft OPP/EFED Small-Scale Prospective Ground-Water Monitoring Study Guidelines (USEPA, 1998, http://www.epa.gov/oscpmont/sap/1998/october/grndwtr.pdf suggest that it is better to base the target on the consumptive needs of the crop. Consumptive use was recommended in the guidance because in many agricultural regions, evapotranspiration exceeds precipitation during the growing season, which reduces the likelihood of leaching.

The monthly precipitation is compared to monthly pan evaporation which is correlated to consumptive use. The monthly means for the meteorological file for MLRA 97 (nearest station, South Bend, Indiana, 1948-1983) the PRZM Input Collator (PIC) running under PIRANHA (Burns, 1992)) are similar to the means (Appendix 4, Three Rivers, MI Station (Station # 208184) Precipitation - 1961 to 1990. Pan evaporation data is also included in the meteorological data for MLRA 97. The average, minimum, median, and maximum monthly precipitation times 1.3 (130 percent of monthly value) were divided by the corresponding monthly ET value and plotted as ratio (RTMEAN, RATIOMIN, RATIONMED, RATIOMAX, respectively). The Unity line is the when pan evaporation and precipitation are equal. Ratio values greater that one indicates that the 130% precipitation exceeded the monthly pan evaporation. When the ratios were less than 1.0, the pan evaporation exceeds precipitation. The results are shown in Figure 1. It can be seen that for the months of May, June, and July the pan evaporation exceeds all monthly 130% precipitation values. For all but January, November, and December, the only the maximum 130 % precipitation values are less than pan evaporation. Thus, for several months following pesticide application, there exist a likelihood that although water is applied at a rate of 1.3 times (130 percent) the monthly precipitation may not be sufficient for leaching. The significance of leaching occurring shortly after the application of the pesticide has been demonstrated by the USDA (Sigua et al. 1993;1995)

There is some uncertainty in comparing the precipitation to pan evaporation. Pan evaporation, while correlated to consumptive use, does not need to be equal (can be more or less). The pan evaporation values might also need to be corrected with a crop coefficient to allow for changes in a plant's water consumption. Crop coefficients can range from 0.2 to 1.2 or more during a growing season. In addition, the study plot was fallow the second year of the study. Recharge would also probably be greater under the "fallowed" (after harvest) condition then had a crop been planted the second year.

Since other fields near the study site are irrigated (presence of existing irrigation system), it is clear that rainfall in that part of Michigan is not always sufficient to grow soybeans or corn.

The amount of water applied (as precipitation or irrigation) to the study site must be sufficient both to grow a crop and to ensure recharge from the surface. Because, the tracer reached ground water during the course of the study, recharge was demonstrated. However, since the target moisture was based on precipitation alone, it is not clear whether added water was sufficient to produce an typical crop yield.

There are a few ways that this could be clarified:

- The yield obtained from the study plot could be compared to yields obtained from elsewhere on the cooperator's farm or from others in the county to demonstrate the production of an average crop. The soybean crop was harvested in 1999, but crop yield was not stated.

- Other fields on the property that included the study site were equipped for irrigation. If the land owner irrigated any of the adjacent fields during the study, it would be instructive to know how the registrant's "target amount of precipitation" compared to the precipitation plus irrigation applied to other fields that the land owner irrigated.

Evaluation of applied water versus historical precipitation

The monthly mean and highest monthly amount for the Three Rivers, Michigan Weather Station for 1961 to 1990 (NOAA Station Number 208184) are summarized in Table J. The extremes are also presented for the period 1895 to 2000. The actual water added to the study plot (measured on site: precipitation plus irrigation), monthly growing target, and cumulative growing season water added is presented in Table K. Missing onsite meteorological data were supplemented by the data from the Three Rivers, Michigan Weather Station (NOAA Station Number 208184) for missing time periods (03/19/01 to 03/31/01 and 04/01/01 to 04/27/01).

Table J. Monthly mean and maximum monthly precipitation for the period 1961 to 1990 at the Three Rivers, Michigan meteorological station (208184) Appendix 4, page 1130.

Month	Mean	Maximum Value
January	1.65	5.04
February	1.49	5.28
March	2.57	5.38
April	3.33	8.38
May	3.32	10.20
June	3.59	8.46
July	3.92	9.40
August	3.27	7.76
September	3.44	7.15
October	2.73	8.55
November	2.81	14.47
December	2.64	9.14
Annual Mean	34.76	
Growing Season 1[1]	16.95 (22.5/16.5)*100 = 132%)	
growing season 2[2]	23.60 (31.95/23.6)*100 = 135%)	

[1] June1999 to October 1999
[2] April 2000 to October 2000

The monthly target amount (1.3 times monthly precipitation) of water to be added, as proposed by the registrant, is given as Growing Season Target in Table K. The amount of water actually added during the study (precipitation plus irrigation) is listed as Water Added Total (Table K). The difference is shown in Table K as Cumulative Growing Season, with the + indicating more water was applied than the target amount and the - indicating less than the target amount was applied. The registrant was not completely successful in meeting their target amount by adding irrigation (supplementing precipitation) water during the crop growing months (April through October) (Table K).

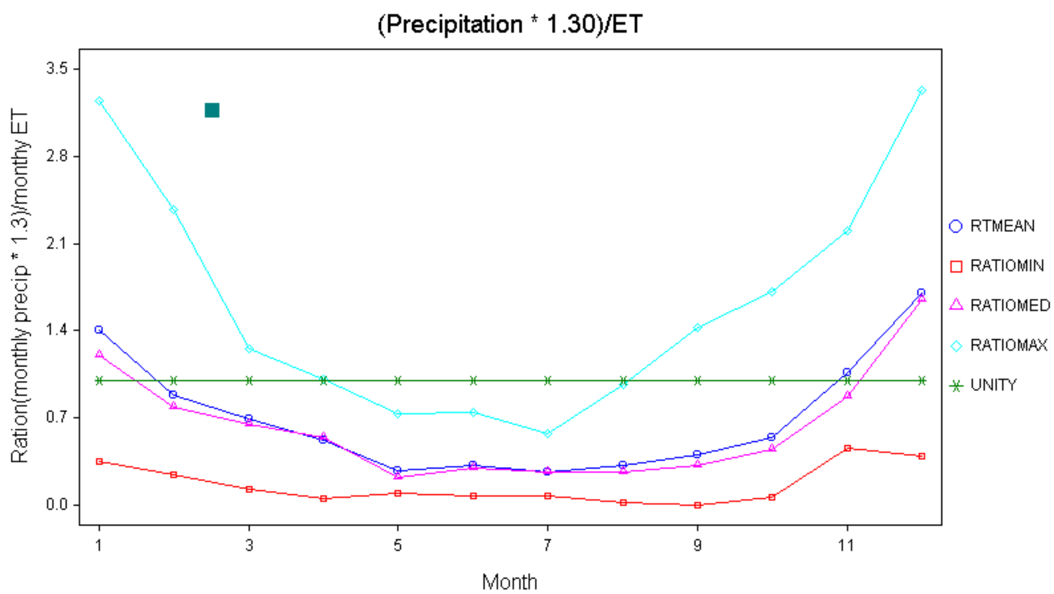
The precipitation reported at the study site during the course of the study is summarized, by year (or part of year), in Table K. Total water input for the first growing season was 22.5 inches (June 1999 to October 1999). During the second growing season (April to October 2000), water input was 31.93 inches or about 135% of the NOAA historical 30-year average (23.6 inches) for the period (Appendix 4, Three Rivers, MI, Precipitation, page 1130).

Table K indicates that the water added only approached a monthly maximum value for only one month during the study. For the 1999 growing season only 2 months (August and October) of actual water added exceeded the monthly target value of 1.3 times the mean. During the 2000 growing season, the actual water applied exceed the target amount in four (May, June, September, October) of seven months. Even when the target was exceeded, the amounts were generally closer to the mean values rather than the maximum monthly values. **Therefore, the study can not be used to represent an upper end recharge scenario. It better represents a vulnerable site with more typical precipitation/irrigation conditions.**

Table K. Three growing season water added (precipitation + irrigation) and growing season target amount (monthly 36 year average) and cumulative balance			
Month	Water Added Total[1] (inches)	Growing Season Target[2] (inches)	Cumulative[3] Growing Season (inches)
Year One Growing Season (1999) (June 10 to Oct. 31)			
June	3.93	3.27 [8.46][4]	+0.66
July	3.25	5.10 [9.40]	-1.19
August	7.71	4.25 [7.76]	+2.27
September	3.82	4.47 [7.15]	+1.62
October	3.79	3.55 [8.5]	+1.86
Cum for Period	22.50	20.64	+1.86
Year Two Growing Season (2000) (April 1 to October 31)			
April	3.75	4.33 [8.38]	-0.58
May	6.03	4.32 [10.20]	+1.13
June	6.16	4.67 [8.46]	+2.62
July	5.10	5.10 [9.40]	+2.62
August	1.82	4.25 [7.76]	+0.19
September	5.06	4.47 [7.15]	+0.78
October	4.01	3.55 [8.5]	16.84
Totals	31.93	30.69	-1.14
Year Three Growing Season (2001) (April 1 to April 27)[5]			
April 2001	2.76	3.90	-1.14

[1] Rainfall plus irrigation. Irrigation amounts are average of the five rain-gauge catches during the irrigation event.
[2] Target Amount, 130 percent of NOAA (Three Rivers, MI, Station 208184) historical (1961-1990) monthly average.
[3] Cumulative Growing Season Surplus (+) or deficit (-) (actual compare to target amount).
[4] Measured maximum monthly precipitation (Three Rivers, MI, Station 208184) historical (1961-1990).
[5] April 27, 2001 is the date that the EPA approved site closure.

Figure 1.



(Precipitation * 1.30)/ET
3.5
2.8
2.1
1.4
0.7
0.0
Ration(monthly precip * 1.3)/monthy ET
1
3
5
7
9
11
Month
RTMEAN
RATIOMIN
RATIOMED
RATIOMAX
UNITY

Citations:

Burke, W., D. Gabriels, and J. Bouma. (eds.). 1986. Soil Structure Assessment. A. A. Balkema. Boston, 1986.

Burns, L.A. 1992. PRZM Input Collator PIC Version 2.0 as part of Pesticide and Industrial Chemical Risk Analysis and Hazard Assessment Version 3.0) Environmental Research Laboratory, U.S. Environmental Protection Agency, Athens, GA

Sigua, G.C., A.R. Isensee, and A.M. Sadeghi. 1993. Influence of rainfall intensity and crop residue on leaching of atrazine through intact no-till soil cores. Soil Sci. 156:225-232.

Sigua, G.C., A.R. Isensee, and A.M. Sadeghi. 1995. Influence of tillage, antecedent moisture, and rainfall timing on atrazine transport. Weed Sci. 43:134-139.

U. S. Department of Agricultural. 1981. Agricultural Handbook 296, Land Resource Regions and Major Land Resources of the United States. US Govt. Printing Office, Washington, DC

U.S. Environmental Protection Agency. 1992. Pesticides in Ground Water Database. A compilation of monitoring studies: 1971 - 1991 National Summary. EPA 734-12-92-001. U. S. Environmental Protection Agency: Arlington, VA

U.S. Environmental Protection Agency. 1998. “Draft” Guidance for Prospective Ground-Water Monitoring Studies. EFED/OPP/USEPA. September 16, 1998. Arlington, VA .http://www.epa.gov/oscpmont/sap/1998/October/grndwtr.pdf

ERRATA

A several minor issues and errors have been identified by the Agency. These issues and errors are being noted so that they can be addressed for correctness and completeness. The final report has been submitted as an acrobat file (pdf) and paper copy, this report does not include the site characterization data, and other information submitted to the Agency in the interim reports. The Agency is not looking Valent to produce a new report, but the re-submittal of site selection data, interim reports along with the final report (all in pdf format) to make a complete stand alone record (e.g., series of pdf files). An outline or table of contents summarizing the organization of these information could accompany these (pdf) files. This is especially important since the final report refers to these other submittals which contain multiple appendices, attachments, and figures.

Additionally, several errors were noted (e.g., incorrect citations, not final drawings). Again the Agency is not interested in new report, but for Valent to evaluate the final report for errors, and develop an ERRATA sheet that notes the location of the error and then sites the correct information.

The final report also appears to present some incorrect information (not final figures) or citation inaccuracies. To correct errors (citations of information, etc) perhaps an irrata sheet could be developed that identifies the error, and or clarification, and the correct information or additional information. Several apparent errors are listed:

1. The final report has used “generalized” or proposed figures (Attachment A2-2, page 140) when the final figures previously presented in the Interim Report (Figure 3, page 54 IR# 1) should have be used. For example, Figure (Attachment A2-2, page 140) appear to show “proposed” soil sample location (SS1 to SS10), whereas Figure 3 (page 54 of Interim Report) shows soil sample locations (SS1 to SS10 - 9-point full characterization samples). It is doubtful that this issue will have an effect on the conclusions reached about this study.

2. The legend on Figure 3 of Interim Report 1 (page 54) depicts the 10-point interim soil characterization sample locations, the 9-point full soil characterization sample locations and the 5-point surface residue point location, none of which appear on the figure. Is this due to poor reproductions (e.g., black-white reproduction from originals with shading and/or color delineations) or erroneous legends?

3. There is a discrepancy between the Final Report (MRID 456917-01) and Interim Report # 1 (MRID 449981-01) as to when piezometer P-1 to P-3 were installed. The Interim Report appears to be correct as it states November 17, 1998 whereas the Final Reports November 11, 1998. The November 17 date appears to be correct as it is supported by the Well Construction and Lithology Logs for Monitoring Wells P-1 to P-3 (MRID 449981-01, pages 164-169). Piezometers P-4 to P-7, according the Lithology Logs, were installed on April 5 and 6, 1999.

.

4. <u>5-Point Analytical Interference Assessment Sampling:</u> On 30 April 1999, five soil samples (at different locations) were collected from 0 to 6, 6 to 12, and 12 to 18 inches below ground surface (bags). (IR #1MRID 449981-01, page 17 and Figure 3, page 54). The samples were to be analyzed under protocol V-99-12155 (D252898).

There is no evidence that the results of this analysis was ever reported.

DER Appendix 1: Sorption of lactofen and acifluorfen to glass, etc.

In earlier reviews, the Agency noted that lactofen and its degradate-metabolite (acifluorfen) were adsorbed to the walls of the glass container (up to 60% was adsorbed reversibly to the walls of the container, DP Barcode D242256). To address this concern, the registrant conducted an experiment to evaluate the sorption of lactofen and acifluorfen to surfaces of stainless steel pipe, PVC pipe, lysimeter ceramic collection cup, and silica powder. The study results were briefly described in the IR # 2 (MRID #45062901) on pages 11 and 12, and in detail in Appendix 2, pages 102 to 129. Solutions containing radio-labeled lactofen and acifluorfen were added to the media test at a rate of about 3.25 ppb lactofen and 1.0 ppb acifluorfen, respectively. The results of this study is summarized in Table I. These data show that lactofen has a high sorption potential to the materials associated with the suction lysimeters, whereas acifluorfen did not.

Table I. Sorption as percentage of radioactivity for lactofen and acifluorfen to sampling device (suction lysimeters) materials[1].

Chemical	Material	Percent Sorption over time as % applied radioactivity		
		Control	1 Day	7 Day
Lactofen	Stainless Steel Pipe	100.0	76.8	76.0
Lactofen	PVC Pipe	100.0	73.2	66.4
		% applied radioactivity		
Lactofen	Dissolved in Water Inside lysimeter cup		1.21	
	Sorbed to Glass Beaker		8.31	
	Sorbed Ceramic Cup Material		90.5	
	Lysimeter Ceramic water collection cup		100.2	
			5-minute	120-minute
Lactofen	Sorbed to silica		59.7	69.0
	Remaining in solution		40.3	31.0
		% applied radioactivity		
Acifluorfen	Total radioactivity in ceramic cup water		80	
	Radioactivity sorbed onto the ceramic cup		18.3	
	Beaker rinse radioactivity		0.70	
	Sum of recovered radioactivity		99.0	

Chemical	Material	Percent Sorption over time as % applied radioactivity		
			5-minute	120-minute
Acifluorfen	Radioactivity remaining in silica water		91	90
	Radioactivity adsorbed to silica powder		9	10

[1] Data obtained from IR#2 (MRID #450629-01, Appendix 2, Tables 1 to 6, pages 102 to 129).

The registrant requested not to analyze soil-pore water samples for lactofen, due to high degree of sorption of lactofen to the materials used in the construction and installation of the suction lysimeters. This request **was** acceptable to Agency. Acifluorfen and bromide would be analyzed for the soil-pore water samples, but not lactofen.(DP Barcode: D252898 Review of Site Location and Study Protocol for Lactofen Prospective Ground Water Study).

Attachment 1: Generalized Summary of Subsurface Soil Characterization Data.
9-point sampling IR#1 MRID #449981-01 Appendix 6-2 pages 183 to 190

Note 1: This data is provide a general characterization of the subsoil at the PGW study site. For more specific needs the raw data should be consulted.

Note 2: The summary of the subsurface soil characterization is considered a "generalized summary" because below 72 inches (layer 12) the sampling increments were not equal (different length segments) or the same (not continuous). Above 72 inches the segments were the same.

Note 3: Piezometer data P1 to P3 are not included. Data for only Monitoring Wells MW-1D to MW-8D and MW-UD are given. Depth increments of the 3 piezometers were slightly different.

Note 4: Layers numbers are used rather than depth increment. A key is given at the end of this table. Layers 1 to 12 are identical for all 9 borings. Thus, the descriptive statistics for layers 1 to 12 represent the values from 9 equal length segments from the same depth. The descriptive statistics for layers 13 to 18 are comprised of samples with different segment lengths and locations.

DESCRIPTIVE STATISTICS FOR LAYER = 1 (0 to 6 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	80.689	12.789	6.5222	4.8000	1.1111	6.6667	8.2556	3.4667
SD	4.7614	3.9467	2.3301	0.6103	0.2028	0.2958	1.3767	0.6364
C.V.	5.9010	30.860	35.726	12.715	18.248	4.4371	16.676	18.358
MINIMUM	74.200	8.0000	1.0000	3.5000	0.9000	6.2000	6.3000	2.6000
MEDIAN	81.000	12.000	7.0000	4.9000	1.1000	6.7000	8.4000	3.3000
MAXIMUM	87.000	18.100	9.0000	5.3000	1.4000	7.0000	10.500	4.1000

DESCRIPTIVE STATISTICS FOR LAYER = 2 (6 to 12 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	81.111	10.778	8.1111	4.3444	0.3889	6.7778	7.7222	3.2889
SD	5.5777	4.0859	2.2048	1.2982	0.1616	0.4790	1.8376	1.0080
C.V.	6.8767	37.910	27.182	29.881	41.552	7.0673	23.797	30.649
MINIMUM	73.000	4.0000	5.0000	2.5000	0.2000	6.0000	4.6000	2.1000
MEDIAN	79.000	13.000	8.0000	4.2000	0.4000	6.9000	7.5000	3.4000
MAXIMUM	91.000	14.000	13.000	6.6000	0.6000	7.4000	10.000	5.3000

DESCRIPTIVE STATISTICS FOR LAYER = 3 (12-18 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	82.444	8.4444	9.1111	5.0000	0.2333	6.7889	7.7222	3.8889
SD	7.1609	3.0046	5.0111	2.5612	0.1500	0.4137	2.9647	2.0895
C.V.	8.6857	35.581	55.000	51.225	64.286	6.0931	38.392	53.731
MINIMUM	73.000	4.0000	1.0000	2.1000	0.0000	6.1000	2.9000	1.4000
MEDIAN	81.000	8.0000	7.0000	4.0000	0.2000	6.9000	7.9000	3.1000
MAXIMUM	95.000	12.000	17.000	8.9000	0.4000	7.3000	11.800	7.6000

DESCRIPTIVE STATISTICS FOR LAYER = 4 (18 to 24 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	82.822	7.0222	10.156	6.5333	0.2444	6.8778	8.1556	4.7556
SD	8.2400	3.0062	6.5676	3.6428	0.1424	0.2728	3.7786	2.6903
C.V.	9.9490	42.809	64.670	55.757	58.255	3.9671	46.332	56.572
MINIMUM	71.000	3.1000	2.3000	2.0000	0.1000	6.4000	3.1000	1.4000
MEDIAN	82.100	7.0000	9.1000	6.9000	0.2000	6.9000	8.8000	4.5000
MAXIMUM	93.500	12.100	19.000	10.900	0.5000	7.3000	13.000	9.0000

DESCRIPTIVE STATISTICS FOR LAYER = 5 (24 to 30 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	86.189	6.6111	7.2000	5.1778	0.4000	6.7222	6.7667	3.5333
SD	4.7155	2.7099	3.6973	1.7669	0.3606	0.5118	2.3065	1.3426
C.V.	5.4711	40.990	51.351	34.125	90.139	7.6136	34.086	37.997
MINIMUM	79.000	3.3000	1.9000	3.0000	0.1000	5.7000	2.5000	1.5000
MEDIAN	87.000	7.0000	5.9000	5.6000	0.2000	6.8000	6.8000	3.5000
MAXIMUM	94.800	11.800	13.000	8.2000	1.1000	7.4000	10.700	6.1000

DESCRIPTIVE STATISTICS FOR LAYER = 6 (30 to 36 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	91.478	3.4111	5.1111	4.1778	0.1444	6.8778	4.9444	2.8444
SD	2.7017	1.6405	2.9345	1.2488	0.0527	0.3667	1.5175	0.8960
C.V.	2.9534	48.092	57.414	29.891	36.488	5.3312	30.691	31.499
MINIMUM	89.000	0.0000	0.0000	2.1000	0.1000	6.0000	2.4000	1.4000
MEDIAN	91.000	4.0000	5.0000	4.5000	0.1000	6.9000	4.9000	3.0000
MAXIMUM	96.200	5.9000	9.0000	5.5000	0.2000	7.3000	6.9000	4.1000

DESCRIPTIVE STATISTICS FOR LAYER = 7 (36 to 42 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	92.778	1.8889	5.3333	3.6333	0.1556	6.8444	4.2889	2.4778
SD	1.9221	1.3642	1.5811	0.5979	0.0527	0.2506	1.0764	0.4868
C.V.	2.0717	72.224	29.646	16.456	33.882	3.6607	25.097	19.645
MINIMUM	89.000	0.0000	3.0000	2.8000	0.1000	6.4000	3.0000	1.8000
MEDIAN	93.000	2.0000	5.0000	3.6000	0.2000	6.8000	4.2000	2.4000
MAXIMUM	96.000	4.0000	7.0000	4.6000	0.2000	7.3000	6.2000	3.3000

DESCRIPTIVE STATISTICS FOR LAYER = 8 (42 to 48 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	91.567	2.1333	6.3000	4.5333	0.1556	6.8111	5.1667	2.9778
SD	3.9230	1.2083	3.2381	1.6485	0.0527	0.4885	2.5085	1.1734
C.V.	4.2843	56.639	51.398	36.364	33.882	7.1718	48.551	39.406
MINIMUM	85.000	1.0000	3.0000	2.8000	0.1000	5.8000	3.1000	1.9000
MEDIAN	93.000	2.0000	5.0000	4.0000	0.2000	6.9000	4.0000	2.5000
MAXIMUM	96.000	4.2000	13.000	7.5000	0.2000	7.4000	10.600	5.1000

DESCRIPTIVE STATISTICS FOR LAYER = 9 (48 to 54 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	91.000	2.6667	6.3333	4.0333	0.1556	6.8111	5.2222	2.8778
SD	2.7839	1.1180	2.2913	1.5182	0.0726	0.4567	2.2747	1.0402
C.V.	3.0592	41.926	36.178	37.642	46.702	6.7058	43.559	36.145
MINIMUM	87.000	1.0000	3.0000	1.9000	0.1000	6.3000	3.0000	1.9000
MEDIAN	91.000	2.0000	6.0000	3.7000	0.1000	6.9000	4.5000	2.4000
MAXIMUM	94.000	4.0000	9.0000	7.0000	0.3000	7.5000	9.3000	5.1000

DESCRIPTIVE STATISTICS FOR LAYER = 10 (54 to 60 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	91.222	2.7778	6.0000	4.3111	0.1444	6.5444	5.4333	2.8556
SD	4.9188	1.6415	3.3912	1.8591	0.0726	0.5703	2.6870	1.1620
C.V.	5.3921	59.093	56.519	43.123	50.295	8.7147	49.454	40.693
MINIMUM	81.000	1.0000	3.0000	1.8000	0.1000	5.6000	2.5000	1.5000
MEDIAN	93.000	2.0000	5.0000	4.7000	0.1000	6.8000	4.4000	2.5000
MAXIMUM	96.000	6.0000	13.000	7.1000	0.3000	7.1000	10.400	4.5000

DESCRIPTIVE STATISTICS FOR LAYER = 11 (60 to 66 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	91.111	2.5556	6.3333	5.0667	0.3667	6.4111	5.3111	3.0111
SD	7.0789	3.0459	4.3301	2.7839	0.8000	0.5776	3.0428	1.4330
C.V.	7.7695	119.19	68.370	54.945	218.18	9.0092	57.291	47.592
MINIMUM	73.000	0.0000	3.0000	1.8000	0.1000	5.5000	2.8000	1.6000
MEDIAN	93.000	2.0000	5.0000	4.0000	0.1000	6.4000	4.1000	2.5000
MAXIMUM	96.000	10.000	17.000	9.7000	2.5000	7.2000	12.500	6.0000

DESCRIPTIVE STATISTICS FOR LAYER = 12 (66 to 72 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	93.211	1.9667	4.8222	4.0889	0.2667	6.7000	3.9111	2.2778
SD	2.0558	1.5684	1.9835	1.4895	0.4272	0.5916	1.3318	0.7276
C.V.	2.2055	79.751	41.133	36.428	160.20	8.8300	34.051	31.945
MINIMUM	91.000	0.0000	2.4000	1.8000	0.1000	5.9000	2.6000	1.5000
MEDIAN	93.000	2.0000	5.0000	3.7000	0.1000	6.6000	3.9000	2.3000
MAXIMUM	96.000	5.7000	7.0000	6.8000	1.4000	8.0000	6.7000	3.9000

DESCRIPTIVE STATISTICS FOR LAYER = 13 (72-76,77-96,96-100,100-144,72-120,72-90,90-100,100-144 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	15	15	15	15	15	15	15	15
MEAN	94.067	1.8000	4.1333	3.6933	0.1333	7.0867	4.3400	1.9800
SD	4.5429	2.0424	2.7740	1.5369	0.0617	0.8493	4.2985	1.4224
C.V.	4.8295	113.47	67.114	41.613	46.291	11.984	99.043	71.837
MINIMUM	83.000	0.0000	1.0000	1.2000	0.0000	6.0000	1.3000	0.7000
MEDIAN	96.000	1.0000	3.0000	3.2000	0.1000	6.9000	2.4000	1.6000
MAXIMUM	98.000	6.0000	11.000	6.9000	0.2000	8.7000	16.700	5.2000

DESCRIPTIVE STATISTICS FOR LAYER = 14 (144-192,120-168 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	8	8	8	8	8	8	8	8
MEAN	96.375	1.6250	2.0000	3.8750	0.2125	7.9625	2.4750	1.2375
SD	1.1877	0.7440	1.0690	1.0990	0.0991	0.8123	0.9558	0.4069
C.V.	1.2324	45.786	53.452	28.362	46.637	10.201	38.619	32.878
MINIMUM	95.000	0.0000	1.0000	2.1000	0.1000	6.8000	1.4000	0.8000
MEDIAN	97.000	2.0000	2.0000	3.9000	0.2000	8.4000	2.3500	1.2000
MAXIMUM	98.000	2.0000	3.0000	5.1000	0.4000	8.7000	4.5000	2.0000

DESCRIPTIVE STATISTICS FOR LAYER = 15 (192-211,168-216 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	9	9	9	9	9	9	9	9
MEAN	94.333	2.5556	3.1111	5.2778	0.1889	8.4889	3.2444	1.3444
SD	2.0000	1.0138	1.6915	1.0545	0.0928	0.3060	0.9964	0.3358
C.V.	2.1201	39.670	54.369	19.980	49.127	3.6042	30.710	24.979
MINIMUM	91.000	1.0000	1.0000	2.8000	0.1000	7.8000	1.7000	0.9000
MEDIAN	95.000	2.0000	3.0000	5.6000	0.2000	8.6000	3.1000	1.3000
MAXIMUM	97.000	4.0000	7.0000	6.1000	0.3000	8.7000	5.0000	2.0000

DESCRIPTIVE STATISTICS FOR LAYER = 16 (211-259,259-288,216-232,232-240,216-244,244-288,216-264,264-300 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	14	14	14	14	14	14	14	14
MEAN	95.300	2.7714	1.9286	5.3714	0.1714	8.7071	2.4929	1.2214
SD	2.1905	2.5886	1.1411	0.7322	0.0726	0.1817	0.9327	0.2940
C.V.	2.2986	93.402	59.170	13.630	42.366	2.0870	37.415	24.069
MINIMUM	89.200	0.0000	0.0000	4.5000	0.1000	8.3000	1.0000	0.8000
MEDIAN	95.000	2.0000	2.0000	5.0500	0.2000	8.7000	2.3500	1.2000
MAXIMUM	98.000	10.800	3.0000	7.2000	0.3000	9.0000	4.0000	2.0000

DESCRIPTIVE STATISTICS FOR LAYER = 17 (288-315,288-306,306-336,264-312,264-292,292-312,300-306 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	10	10	10	10	10	10	10	10
MEAN	82.200	8.9000	8.9000	6.8600	0.2300	8.5500	6.1200	3.2600
SD	18.097	9.3980	8.7743	2.6734	0.0823	0.1958	5.3905	2.7293
C.V.	22.016	105.60	98.588	38.971	35.794	2.2899	88.080	83.722
MINIMUM	59.000	1.0000	1.0000	3.9000	0.1000	8.3000	1.0000	0.6000
MEDIAN	95.000	2.0000	3.0000	5.6000	0.2000	8.5000	2.4000	1.4000
MAXIMUM	98.000	22.000	21.000	10.900	0.4000	8.9000	13.900	6.9000

DESCRIPTIVE STATISTICS FOR LAYER = 18 (330-336 inches)

	SAND	SILT	CLAY	CEC	OM	PH	FC1_3BAR	WP15BAR
N	3	3	3	3	3	3	3	3
MEAN	68.000	12.667	19.333	8.1000	0.4333	8.3667	11.767	6.5000
SD	28.618	8.7369	24.214	4.5902	0.5774	0.2082	11.094	7.6544
C.V.	42.086	68.975	125.25	56.669	133.23	2.4880	94.286	117.76
MINIMUM	38.000	3.0000	2.0000	3.9000	0.1000	8.2000	1.6000	0.8000
MEDIAN	71.000	15.000	9.0000	7.4000	0.1000	8.3000	10.100	3.5000
MAXIMUM	95.000	20.000	47.000	13.000	1.1000	8.6000	23.600	15.200

Sample Point	Layer	Depth Increment
MW-UD	1.0	0-6
MW-UD	2.0	6-12
MW-UD	3.0	12-18
MW-UD	4.0	18-24
MW-UD	5.0	24-30
MW-UD	6.0	30-36
MW-UD	7.0	36-42
MW-UD	8.0	42-48
MW-UD	9.0	48-54
MW-UD	10.0	54-60
MW-UD	11.0	60-66
MW-UD	12.0	66-72
MW-UD	13.1	72-77
MW-UD	13.2	77-96
MW-UD	13.3	96-100
MW-UD	13.5	100-144
MW-UD	14.2	144-192
MW-UD	15.2	192-211
MW-UD	16.2	211-259
MW-UD	16.5	259-288
MW-UD	17.2	288-315
MW-1D	1.0	0-6
MW-1D	2.0	6-12
MW-1D	3.0	12-18
MW-1D	4.0	18-24
MW-1D	5.0	24-30
MW-1D	6.0	30-36
MW-1D	7.0	36-42
MW-1D	8.0	42-48
MW-1D	9.0	48-54
MW-1D	10.0	54-60
MW-1D	11.0	60-66
MW-1D	12.0	66-72
MW-1D	13.0	72-120
MW-1D	14.0	120-168
MW-1D	15.0	168-216
MW-1D	16.1	216-232
MW-1D	16.2	232-240
MW-1D	16.5	240-288
MW-1D	17.2	288-306
MW-1D	17.4	306-336
MW-2D	1.0	0-6
MW-2D	2.0	6-12
MW-2D	3.0	12-18
MW-2D	4.0	18-24
MW-2D	5.0	24-30
MW-2D	6.0	30-36
MW-2D	7.0	36-42
MW-2D	8.0	42-48
MW-2D	9.0	48-54
MW-2D	10.0	54-60
MW-2D	11.0	60-66
MW-2D	12.0	66-72
MW-2D	13.2	72-90
MW-2D	13.3	90-100
MW-2D	13.5	100-144
MW-2D	13.7	144-168
MW-2D	15.0	168-216
MW-2D	16.5	216-244
MW-2D	16.9	244-288
MW-3D	1.0	0-6
MW-3D	2.0	6-12

MW-3D	3.0	12-18
MW-3D	4.0	18-24
MW-3D	5.0	24-30
MW-3D	6.0	30-36
MW-3D	7.0	36-42
MW-3D	8.0	42-48
MW-3D	9.0	48-54
MW-3D	10.0	54-60
MW-3D	11.0	60-66
MW-3D	12.0	66-72
MW-3D	13.0	72-120
MW-3D	14.0	120-168
MW-3D	15.0	168-216
MW-3D	16.0	216-264
MW-3D	17.0	264-312
MW-4D	1.0	0-6
MW-4D	2.0	6-12
MW-4D	3.0	12-18
MW-4D	4.0	18-24
MW-4D	5.0	24-30
MW-4D	6.0	30-36
MW-4D	7.0	36-42
MW-4D	8.0	42-48
MW-4D	9.0	48-54
MW-4D	10.0	54-60
MW-4D	11.0	60-66
MW-4D	12.0	66-72
MW-4D	13.0	72-120
MW-4D	14.0	120-168
MW-4D	15.0	168-216
MW-4D	16.0	216-264
MW-4D	17.1	264-292
MW-4D	17.2	292-312
MW-5D	1.0	0-6
MW-5D	2.0	6-12
MW-5D	3.0	12-18
MW-5D	4.0	18-24
MW-5D	5.0	24-30
MW-5D	6.0	30-36
MW-5D	7.0	36-42
MW-5D	8.0	42-48
MW-5D	9.0	48-54
MW-5D	10.0	54-60
MW-5D	11.0	60-66
MW-5D	12.0	66-72
MW-5D	13.0	72-120
MW-5D	14.0	120-168
MW-5D	15.0	168-216
MW-5D	16.0	216-264
MW-5D	17.0	264-312
MW-5D	18.0	312-336
MW-6D	1.0	0-6
MW-6D	2.0	6-12
MW-6D	3.0	12-18
MW-6D	4.0	18-24
MW-6D	5.0	24-30
MW-6D	6.0	30-36
MW-6D	7.0	36-42
MW-6D	8.0	42-48
MW-6D	9.0	48-54
MW-6D	10.0	54-60
MW-6D	11.0	60-66
MW-6D	12.0	66-72
MW-6D	13.0	72-120

MW-6D	14.0	120-168
MW-6D	15.0	168-216
MW-6D	16.0	216-264
MW-6D	16.2	264-300
MW-6D	17.2	300-306
MW-6D	18.0	330-336
MW-7D	1.0	0-6
MW-7D	2.0	6-12
MW-7D	3.0	12-18
MW-7D	4.0	18-24
MW-7D	5.0	24-30
MW-7D	6.0	30-36
MW-7D	7.0	36-42
MW-7D	8.0	42-48
MW-7D	9.0	48-54
MW-7D	10.0	54-60
MW-7D	11.0	60-66
MW-7D	12.0	66-72
MW-7D	13.0	72-120
MW-7D	14.0	120-168
MW-7D	15.0	168-216
MW-7D	16.0	216-264
MW-7D	17.2	300-306
MW-8D	1.0	0-6
MW-8D	2.0	6-12
MW-8D	3.0	12-18
MW-8D	4.0	18-24
MW-8D	5.0	24-30
MW-8D	6.0	30-36
MW-8D	7.0	36-42
MW-8D	8.0	42-48
MW-8D	9.0	48-54
MW-8D	10.0	54-60
MW-8D	11.0	60-66
MW-8D	12.0	66-72
MW-8D	13.0	72-120
MW-8D	14.0	120-168
MW-8D	15.0	168-216
MW-8D	16.0	216-264
MW-8D	17.2	300-306
MW-8D	18.3	330-336